

**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application.

**Listing of Claims:**

Claim 1 (currently amended): A method of augmenting a tomographic projection image of a patient, the method comprising the steps of:

obtaining a first sinogram data set from a patient, the first sinogram data set including incomplete or imperfect data;

reconstructing the first sinogram data set into a first image;

aligning the first image to a second image, the second image being separate and independent from the first image and obtained from the patient at a different time from the first image, the second image including complete image data to obtain an aligned image, so that optimal registration between the first and second image is obtained;

reprojecting the aligned image into a reprojected sinogram data set;

extracting data from the reprojected sinogram data set that is missing from or not available in the first sinogram data set;

augmenting the first sinogram data set with the extracted data from the reprojected sinogram data set to obtain an augmented sinogram data set; and

reconstructing the augmented sinogram data set into a third image.

Claim 2 (currently amended): A method of augmenting a tomographic projection image of a patient, the method comprising the steps of:

converting a first limited data sinogram obtained from a patient to a first limited image,  
the first limited data sinogram and the first limited image including incomplete or imperfect data;

fusing the first limited image to a second complete image, the second complete image  
being separate and independent from the first image and obtained from the patient at a different  
time from the first limited image, the second complete image including complete image data to  
obtain a transformed complete image;

reprojecting a sinogram data set from the transformed complete image to obtain a  
reprojected complete data sinogram;

augmenting the first limited data sinogram with additional data obtained from the  
reprojected complete data sinogram data set from the transformed complete image to obtain an  
augmented limited data sinogram; and

converting the augmented limited data sinogram into an augmented image.

Claim 3 (currently amended): The method according to claim 2 wherein the step of  
fusing comprises the steps of extracting certain features from the first limited image and the  
second complete image and registering the features into the transformed complete image.

Claim 4 (previously presented): The method according to claim 2 wherein the step of  
fusing is performed manually.

Claim 5 (previously presented): The method according to claim 2 wherein the step of  
fusing is performed automatically.

Claim 6 (previously presented): The method according to claim 2 wherein the step of fusing is performed using geometric features, gradient methods or voxel-similarity techniques.

Claim 7 (currently amended): The method according to claim 2 wherein the first limited data sinogram, the reprojected complete data sinogram and the augmented ~~limited~~ data sinogram is represented by a data matrix wherein each row represents an angle and each column represents a distance.

Claim 8 (currently amended): The method according to claim 6 further comprising the steps of comparing the data matrix of the reprojected complete data sinogram ~~is to the data~~ matrix for the first limited data sinogram and determining what data is missing from the first limited data sinogram.

Claim 9 (currently amended): The method according to claim 2 further comprising the steps of using the augmented image ~~converted from the limited data sinogram~~ for ~~one~~ any of the following: contouring, patient setup, patient repositioning, dose registration, dose calculation, dose patching, dose reconstruction, dose verification, delivery modification, plan selection, replanning, re-optimization, delivery verification, deformable patient registration, and deformable dose registration.

Claim 10 (previously presented): The method according to claim 1 wherein the step of aligning comprises the steps of extracting certain features from the first image and the second image and registering the features.

Claim 11 (previously presented): The method according to claim 1 wherein the step of aligning comprises using common radiotherapy patient setup protocols.

Claim 12 (previously presented): The method according to claim 1 wherein the first sinogram data set, the reprojected sinogram data set and the augmented sinogram data set are represented by a data matrix wherein each row represents an angle and each column represents distance.

Claim 13 (currently amended): The method according to claim 1 further ~~including step of using the third image for one of the following: patient setup, contouring, dose registration, delivery verification, deformable patient registration, and deformable dose registration~~ comprising the steps of using the augmented image for any of the following: contouring, patient setup, patient repositioning, dose registration, dose calculation, dose patching, dose reconstruction, dose verification, delivery modification, plan selection, replanning, re-optimization, delivery verification, deformable patient registration, and deformable dose registration.

Claim 14 (currently amended): A method of reconstructing a limited data image from a complete data image, the method comprising the steps of:

obtaining a first sinogram data set from a patient, the first sinogram data set including incomplete, imperfect or limited data;

reconstructing the first sinogram data set into a first image;

obtaining a second ~~image~~ sinogram data set from the patient at a different time from the first sinogram data set, the second sinogram data set including more complete data than the first sinogram data set;

reconstructing the second sinogram data set into a second image;

fusing the first image to the second image;

realigning the second image to the first image to obtain an aligned image;

reprojecting the aligned image into a reprojected sinogram data set;

merging the first sinogram data set by extracting data from the reprojected sinogram data set that is missing from or not available in the first sinogram data set to obtain an augmented sinogram data set; and

reconstructing the augmented sinogram data set into a fusion-aligned reprojection image.

Claim 15 (canceled)

Claim 16 (canceled)

Claim 17 (currently amended): The method according to claim 14 wherein the second ~~image~~ sinogram data set includes ~~contains~~ limited data, but is less-limited or limited in a different manner than the first sinogram data set such that the first sinogram data set can be augmented from ~~a~~ the second sinogram data set or the reprojected sinogram data set.

Claim 18 (currently amended): The method according to claim 14 wherein the first image is realigned to the second image to obtain an aligned image, the aligned image is reprojected into a reprojected sinogram data set, and ~~extracting data~~ is extracted from the

reprojected sinogram data set to augment data into the first or second sinogram data set to obtain an augmented sinogram data set.

Claim 19 (currently amended): A method of augmenting a tomographic projection image of a patient, the method comprising the steps of:

obtaining a first sinogram data set from a patient, the first sinogram data set including incomplete, imperfect or limited data;

obtaining a second sinogram data set from the patient at a different time from the first sinogram data set, the second sinogram data set including complete data;

fusing the first sinogram data set to the second sinogram data set to obtain an aligned sinogram data set, so that optimal registration between the first and second sinogram data sets is obtained;

merging the first sinogram data set with the aligned sinogram data set by extracting data from the aligned sinogram data set that is missing from or not available in the first sinogram data set to obtain an augmented sinogram data set; and

reconstructing the augmented sinogram data set into a fusion-aligned reprojection image.

Claim 20 (new): The method according to claim 1 wherein the first sinogram data set is converted to an artifact-prone image.

Claim 21 (new): The method according to claim 1 wherein the step of aligning comprises using common radiotherapy patient setup protocols.

Claim 22 (new): The method according to claim 1 wherein the first and second images are sufficiently well aligned that explicit fusion is not necessary.

Claim 23 (new): The method according to claim 1 wherein the first sinogram data set, the reprojected sinogram data set and the augmented sinogram data set are represented by a data matrix wherein each row represents a gantry position, a gantry angle, or a ray angle; and each column represents a detector number, a detector distance, a detector angle, or a ray position; and a third sinogram dimension may optionally represent multiple detector rows.

Claim 24 (new): The method according to claim 1 wherein the first sinogram data set is obtained from megavoltage CT images and the second image is obtained from kilovoltage CT images.

Claim 25 (new): The method according to claim 1 wherein the first sinogram data set is obtained from kilovoltage CT images and the second image is obtained from megavoltage CT images.

Claim 26 (new): The method according to claim 1 wherein the first sinogram data set is obtained from CT images and the second image is obtained from MRI images.

Claim 27 (new): The method according to claim 1 wherein the first sinogram data set is obtained from MRI images and the second image is obtained from CT images.

Claim 28 (new): The method according to claim 1 wherein the first sinogram data set is obtained from CT images and the second image is obtained from PET images.

Claim 29 (new): The method according to claim 1 wherein the first sinogram data set is obtained from PET images and the second image is obtained from CT images.

Claim 30 (new): The method according to claim 1 wherein the first sinogram data set is obtained from MRI images and the second image is obtained from PET images.

Claim 31 (new): The method according to claim 1 wherein the first sinogram data set is obtained from PET images and the second image is obtained from MRI images.

Claim 32 (new): The method according to claim 1 further comprising the step of completing one or more iterations by substituting the third image for the first image.

Claim 33 (new): The method according to claim 1 wherein the first sinogram data set is obtained from a tomographic or volume-imaging modality.

Claim 34 (new): The method according to claim 1 wherein the second image is obtained from a tomographic or volume-imaging modality.

Claim 35 (new): The method according to claim 1 wherein any of the sinograms or images are collected using fan-beam geometries.

Claim 36 (new): The method according to claim 1 wherein any of the sinograms or images are collected using cone-beam geometries.

Claim 37 (new): The method according to claim 1 wherein any of the sinograms or images are collected using helical geometries.



Claim 38 (new): The method according to claim 1 wherein any of the sinograms or images are collected using planar image or data converted into tomographic-equivalent images or sinograms, or volume images.

Claim 39 (new): The method according to claim 1 wherein the steps of extracting data and/or augmenting data utilizes patient shape, size, or density information.

Claim 40 (new): The method according to claim 1 wherein the patient's size, shape, and/or anatomy has changed between the collection of the first and second images or data sets.

Claim 41 (new): The method according to claim 2 wherein the first limited data sinogram is converted to an artifact-prone image.

Claim 42 (new): The method according to claim 2 wherein the step of fusing comprises using common radiotherapy patient setup protocols.

Claim 43 (new): The method according to claim 2 wherein the first limited image and the second complete image are sufficiently well aligned that explicit fusion is not necessary.

Claim 44 (new): The method according to claim 2 wherein the first limited data sinogram, the reprojected complete data sinogram and the augmented limited data sinogram are represented by a data matrix wherein each row represents a gantry position, a gantry angle, or a ray angle; and each column represents a detector number, a detector distance, a detector angle, or a ray position; and a third sinogram dimension may optionally represent multiple detector rows.

Claim 45 (new): The method according to claim 2 wherein the first limited data sinogram is obtained from megavoltage CT images and the second complete image is obtained from kilovoltage CT images.

Claim 46 (new): The method according to claim 2 wherein the first limited data sinogram is obtained from kilovoltage CT images and the second complete image is obtained from megavoltage CT images.

Claim 47 (new): The method according to claim 2 wherein the first limited data sinogram is obtained from CT images and the second complete image is obtained from MRI images.

Claim 48 (new): The method according to claim 2 wherein the first limited data sinogram is obtained from MRI images and the second complete image is obtained from CT images.

Claim 49 (new): The method according to claim 2 wherein the first limited data sinogram is obtained from CT images and the second complete image is obtained from PET images.

Claim 50 (new): The method according to claim 2 wherein the first limited data sinogram is obtained from PET images and the second complete image is obtained from CT images.

Claim 51 (new): The method according to claim 2 wherein the first limited data sinogram is obtained from MRI images and the second complete image is obtained from PET images.

Claim 52 (new): The method according to claim 2 wherein the first limited data sinogram is obtained from PET images and the second complete image is obtained from MRI images.

Claim 53 (new): The method according to claim 2 further comprising the step of completing one or more iterations by substituting the augmented image for the first limited image.

Claim 54 (new): The method according to claim 2 wherein the first limited data sinogram is obtained from a tomographic or volume-imaging modality.

Claim 55 (new): The method according to claim 2 wherein the second complete image is obtained from a tomographic or volume-imaging modality.

Claim 56 (new): The method according to claim 2 wherein any of the sinograms or images are collected using fan-beam geometries.

Claim 57 (new): The method according to claim 2 wherein any of the sinograms or images are collected using cone-beam geometries.

Claim 58 (new): The method according to claim 2 wherein any of the sinograms or images are collected using helical geometries.

Claim 59 (new): The method according to claim 2 wherein any of the sinograms or images are collected using planar image or data converted into tomographic-equivalent images or sinograms, or volume images.

Claim 60 (new): The method according to claim 2 wherein the step of augmenting data utilizes patient shape, size, or density information.

Claim 61 (new): The method according to claim 2 wherein the patient's size, shape, and/or anatomy has changed between the collection of the first and second images or data sets.

Claim 62 (new): The method according to claim 14 wherein the first sinogram data set is converted to an artifact-prone image.

Claim 63 (new): The method according to claim 14 wherein the step of fusing comprises using common radiotherapy patient setup protocols.

Claim 64 (new): The method according to claim 14 wherein the first and second images are sufficiently well aligned that explicit fusion is not necessary.

Claim 65 (new): The method according to claim 14 wherein the first sinogram data set, the reprojected sinogram data set and the augmented sinogram data set are represented by a data matrix wherein each row represents a gantry position, a gantry angle, or a ray angle; and each column represents a detector number, a detector distance, a detector angle, or a ray position; and a third sinogram dimension may optionally represent multiple detector rows.

Claim 66 (new): The method according to claim 14 wherein the first sinogram data set is obtained from megavoltage CT images and the second sinogram data set is obtained from kilovoltage CT images.

Claim 67 (new): The method according to claim 14 wherein the first sinogram data set is obtained from kilovoltage CT images and the second sinogram data set is obtained from megavoltage CT images.

Claim 68 (new): The method according to claim 14 wherein the first sinogram data set is obtained from CT images and the second sinogram data set is obtained from MRI images.

Claim 69 (new): The method according to claim 14 wherein the first sinogram data set is obtained from MRI images and the second sinogram data set is obtained from CT images.

Claim 70 (new): The method according to claim 14 wherein the first sinogram data set is obtained from CT images and the second sinogram data set is obtained from PET images.

Claim 71 (new): The method according to claim 14 wherein the first sinogram data set is obtained from PET images and the second sinogram data set is obtained from CT images.

Claim 72 (new): The method according to claim 14 wherein the first sinogram data set is obtained from MRI images and the second sinogram data set is obtained from PET images.

Claim 73 (new): The method according to claim 14 wherein the first sinogram data set is obtained from PET images and the second sinogram data set is obtained from MRI images.

Claim 74 (new): The method according to claim 14 further comprising the step of completing one or more iterations by substituting the fusion-aligned reprojection image for the first image.

Claim 75 (new): The method according to claim 14 wherein the first sinogram data set is obtained from a tomographic or volume-imaging modality.

Claim 76 (new): The method according to claim 14 wherein the second sinogram data set is obtained from a tomographic or volume-imaging modality.

Claim 77 (new): The method according to claim 14 wherein any of the sinograms or images are collected using fan-beam geometries.

Claim 78 (new): The method according to claim 14 wherein any of the sinograms or images are collected using cone-beam geometries.

Claim 79 (new): The method according to claim 14 wherein any of the sinograms or images are collected using helical geometries.

Claim 80 (new): The method according to claim 14 wherein any of the sinograms or images are collected using planar image or data converted into tomographic-equivalent images or sinograms, or volume images.

Claim 81 (new): The method according to claim 14 wherein the step of merging utilizes patient shape, size, or density information.

Claim 82 (new): The method according to claim 14 wherein the patient's size, shape, and/or anatomy has changed between the collection of the first and second images or data sets.

Claim 83 (new): The method according to claim 19 wherein the first sinogram data set is converted to an artifact-prone image.

Claim 84 (new): The method according to claim 19 wherein the step of fusing comprises using common radiotherapy patient setup protocols.

Claim 85 (new): The method according to claim 19 wherein the sinogram data sets are sufficiently well aligned that explicit fusion is not necessary.

Claim 86 (new): The method according to claim 19 wherein the first sinogram data set, the aligned sinogram data set and the augmented sinogram data set are represented by a data matrix wherein each row represents a gantry position, a gantry angle, or a ray angle; and each column represents a detector number, a detector distance, a detector angle, or a ray position; and a third sinogram dimension may optionally represent multiple detector rows.

Claim 87 (new): The method according to claim 19 wherein the first sinogram data set is obtained from megavoltage CT images and the second sinogram data set is obtained from kilovoltage CT images.

Claim 88 (new): The method according to claim 19 wherein the first sinogram data set is obtained from kilovoltage CT images and the second sinogram data set is obtained from megavoltage CT images.

Claim 89 (new): The method according to claim 19 wherein the first sinogram data set is obtained from CT images and the second sinogram data set is obtained from MRI images.

Claim 90 (new): The method according to claim 19 wherein the first sinogram data set is obtained from MRI images and the second sinogram data set is obtained from CT images.

Claim 91 (new): The method according to claim 19 wherein the first sinogram data set is obtained from CT images and the second sinogram data set is obtained from PET images.

Claim 92 (new): The method according to claim 19 wherein the first sinogram data set is obtained from PET images and the second sinogram data set is obtained from CT images.

Claim 93 (new): The method according to claim 19 wherein the first sinogram data set is obtained from MRI images and the second sinogram data set is obtained from PET images.

Claim 94 (new): The method according to claim 19 wherein the first sinogram data set is obtained from PET images and the second sinogram data set is obtained from MRI images.

Claim 95 (new): The method according to claim 19 further comprising the step of completing one or more iterations by substituting the augmented sinogram data set for the first sinogram data set.

Claim 96 (new): The method according to claim 19 wherein the first sinogram data set is obtained from a tomographic or volume-imaging modality.

Claim 97 (new): The method according to claim 19 wherein the second sinogram data set is obtained from a tomographic or volume-imaging modality.



Claim 98 (new): The method according to claim 19 wherein any of the sinograms or images are collected using fan-beam geometries.

Claim 99 (new): The method according to claim 19 wherein any of the sinograms or images are collected using cone-beam geometries.

Claim 100 (new): The method according to claim 19 wherein any of the sinograms or images are collected using helical geometries.

Claim 101 (new): The method according to claim 19 wherein any of the sinograms or images are collected using planar image or data converted into tomographic-equivalent images or sinograms, or volume images.

Claim 102 (new): The method according to claim 19 wherein the step of merging utilizes patient shape, size, or density information.

Claim 103 (new): The method according to claim 19 wherein the patient's size, shape, and/or anatomy has changed between the collection of the first and second data sets.

Claim 104 (new): A method of augmenting a tomographic projection image of a patient, the method comprising the steps of:

obtaining a first sinogram data set from a patient, the first sinogram data set including incomplete or imperfect data;

reconstructing the first sinogram data set into a first image;

aligning the first image to a second image, the second image being separate and independent from the first image and obtained from the patient using a different imaging

apparatus or modality than the first image, the second image including complete image data to obtain an aligned image, so that optimal registration between the first and second image is obtained;

reprojecting the aligned image into a reprojected sinogram data set;

extracting data from the reprojected sinogram data set that is missing from or not available in the first sinogram data set;

augmenting the first sinogram data set with the extracted data from the reprojected sinogram data set to obtain an augmented sinogram data set; and

reconstructing the augmented sinogram data set into a third image.

Claim 105 (new): The method according to claim 104 wherein the first sinogram data set is converted to an artifact-prone image.

Claim 106 (new): The method according to claim 104 wherein the step of aligning comprises using common radiotherapy patient setup protocols.

Claim 107 (new): The method according to claim 104 wherein the first and second images are sufficiently well aligned that explicit fusion is not necessary.

Claim 108 (new): The method according to claim 104 wherein the first sinogram data set, the reprojected sinogram data set and the augmented sinogram data set are represented by a data matrix wherein each row represents a gantry position, a gantry angle, or a ray angle; and each column represents a detector number, a detector distance, a detector angle, or a ray position; and a third sinogram dimension may optionally represent multiple detector rows.

Claim 109 (new): The method according to claim 104 wherein the first sinogram data set is obtained from megavoltage CT images and the second image is obtained from kilovoltage CT images.

Claim 110 (new): The method according to claim 104 wherein the first sinogram data set is obtained from kilovoltage CT images and the second image is obtained from megavoltage CT images.

Claim 111 (new): The method according to claim 104 wherein the first sinogram data set is obtained from CT images and the second image is obtained from MRI images.

Claim 112 (new): The method according to claim 104 wherein the first sinogram data set is obtained from MRI images and the second image is obtained from CT images.

Claim 113 (new): The method according to claim 104 wherein the first sinogram data set is obtained from CT images and the second image is obtained from PET images.

Claim 114 (new): The method according to claim 104 wherein the first sinogram data set is obtained from PET images and the second image is obtained from CT images.

Claim 115 (new): The method according to claim 104 wherein the first sinogram data set is obtained from MRI images and the second image is obtained from PET images.

Claim 116 (new): The method according to claim 104 wherein the first sinogram data set is obtained from PET images and the second image is obtained from MRI images.

Claim 117 (new): The method according to claim 104 further comprising the step of completing one or more iterations by substituting the third image for the first image.

Claim 118 (new): The method according to claim 104 wherein the first sinogram data set is obtained from a tomographic or volume-imaging modality.

Claim 119 (new): The method according to claim 104 wherein the second image is obtained from a tomographic or volume-imaging modality.

Claim 120 (new): The method according to claim 104 wherein any of the sinograms or images are collected using fan-beam geometries.

Claim 121 (new): The method according to claim 104 wherein any of the sinograms or images are collected using cone-beam geometries.

Claim 122 (new): The method according to claim 104 wherein any of the sinograms or images are collected using helical geometries.

Claim 123 (new): The method according to claim 104 wherein any of the sinograms or images are collected using planar image or data converted into tomographic-equivalent images or sinograms, or volume images.

Claim 124 (new): The method according to claim 104 wherein the steps of extracting data and/or augmenting data utilizes patient shape, size, or density information.

Claim 125 (new): The method according to claim 104 wherein the patient's size, shape, and/or anatomy has changed between the collection of the first and second images or data sets.

Claim 126 (new): A method of augmenting a tomographic projection image of a patient, the method comprising the steps of:

converting a first limited data sinogram obtained from a patient to a first limited image, the first limited data sinogram and the first limited image including incomplete or imperfect data;

fusing the first limited image to a second complete image, the second complete image being separate and independent from the first image and obtained from the patient using a different imaging apparatus or modality than the first limited image, the second complete image including complete image data to obtain a transformed complete image;

reprojecting a sinogram data set from the transformed complete image to obtain a reprojected complete data sinogram;

augmenting the first limited data sinogram with additional data obtained from the reprojected complete data sinogram to obtain an augmented limited data sinogram; and

converting the augmented limited data sinogram into an augmented image.

Claim 127 (new): The method according to claim 126 wherein the first limited data sinogram is converted to an artifact-prone image.

Claim 128 (new): The method according to claim 126 wherein the step of fusing comprises using common radiotherapy patient setup protocols.

Claim 129 (new): The method according to claim 126 wherein the first limited image and the second complete image are sufficiently well aligned that explicit fusion is not necessary.

Claim 130 (new): The method according to claim 126 wherein the first limited data sinogram, the reprojected complete data sinogram and the augmented limited data sinogram are represented by a data matrix wherein each row represents a gantry position, a gantry angle, or a ray angle; and each column represents a detector number, a detector distance, a detector angle, or a ray position; and a third sinogram dimension may optionally represent multiple detector rows.

Claim 131 (new): The method according to claim 126 wherein the first limited data sinogram is obtained from megavoltage CT images and the second complete image is obtained from kilovoltage CT images.

Claim 132 (new): The method according to claim 126 wherein the first limited data sinogram is obtained from kilovoltage CT images and the second complete image is obtained from megavoltage CT images.

Claim 133 (new): The method according to claim 126 wherein the first limited data sinogram is obtained from CT images and the second complete image is obtained from MRI images.

Claim 134 (new): The method according to claim 126 wherein the first limited data sinogram is obtained from MRI images and the second complete image is obtained from CT images.

Claim 135 (new): The method according to claim 126 wherein the first limited data sinogram is obtained from CT images and the second complete image is obtained from PET images.

Claim 136 (new): The method according to claim 126 wherein the first limited data sinogram is obtained from PET images and the second complete image is obtained from CT images.

Claim 137 (new): The method according to claim 126 wherein the first limited data sinogram is obtained from MRI images and the second complete image is obtained from PET images.

Claim 138 (new): The method according to claim 126 wherein the first limited data sinogram is obtained from PET images and the second complete image is obtained from MRI images.

Claim 139 (new): The method according to claim 126 further comprising the step of completing one or more iterations by substituting the augmented image for the first limited image.

Claim 140 (new): The method according to claim 126 wherein the first limited data sinogram is obtained from a tomographic or volume-imaging modality.

Claim 141 (new): The method according to claim 126 wherein the second complete image is obtained from a tomographic or volume-imaging modality.

Claim 142 (new): The method according to claim 126 wherein any of the sinograms or images are collected using fan-beam geometries.

Claim 143 (new): The method according to claim 126 wherein any of the sinograms or images are collected using cone-beam geometries.

Claim 144 (new): The method according to claim 126 wherein any of the sinograms or images are collected using helical geometries.

Claim 145 (new): The method according to claim 126 wherein any of the sinograms or images are collected using planar image or data converted into tomographic-equivalent images or sinograms, or volume images.

Claim 146 (new): The method according to claim 126 wherein the step of augmenting data utilizes patient shape, size, or density information.

Claim 147 (new): The method according to claim 126 wherein the patient's size, shape, and/or anatomy has changed between the collection of the first and second images or data sets.

Claim 148 (new): A method of reconstructing a limited data image from a complete data image, the method comprising the steps of:

- obtaining a first sinogram data set from a patient, the first sinogram data set including incomplete, imperfect or limited data;

- reconstructing the first sinogram data set into a first image;

- obtaining a second sinogram data set from the patient using a different imaging apparatus or modality than the first sinogram data set, the second sinogram data set including more complete data than the first sinogram data set;

- reconstructing the second sinogram data set into a second image;



fusing the first image to the second image;  
realigning the second image to the first image to obtain an aligned image;  
reprojecting the aligned image into a reprojected sinogram data set;  
merging the first sinogram data set by extracting data from the reprojected sinogram data set that is missing from or not available in the first sinogram data set to obtain an augmented sinogram data set; and  
reconstructing the augmented sinogram data set into a fusion-aligned reprojection image.

Claim 149 (new): The method according to claim 148 wherein the first sinogram data set is converted to an artifact-prone image.

Claim 150 (new): The method according to claim 148 wherein the step of fusing comprises using common radiotherapy patient setup protocols.

Claim 151 (new): The method according to claim 148 wherein the first and second images are sufficiently well aligned that explicit fusion is not necessary.

Claim 152 (new): The method according to claim 148 wherein the first sinogram data set, the reprojected sinogram data set and the augmented sinogram data set are represented by a data matrix wherein each row represents a gantry position, a gantry angle, or a ray angle; and each column represents a detector number, a detector distance, a detector angle, or a ray position; and a third sinogram dimension may optionally represent multiple detector rows.

Claim 153 (new): The method according to claim 148 wherein the first sinogram data set is obtained from megavoltage CT images and the second sinogram data set is obtained from kilovoltage CT images.

Claim 154 (new): The method according to claim 148 wherein the first sinogram data set is obtained from kilovoltage CT images and the second sinogram data set is obtained from megavoltage CT images.

Claim 155 (new): The method according to claim 148 wherein the first sinogram data set is obtained from CT images and the second sinogram data set is obtained from MRI images.

Claim 156 (new): The method according to claim 148 wherein the first sinogram data set is obtained from MRI images and the second sinogram data set is obtained from CT images.

Claim 157 (new): The method according to claim 148 wherein the first sinogram data set is obtained from CT images and the second sinogram data set is obtained from PET images.

Claim 158 (new): The method according to claim 148 wherein the first sinogram data set is obtained from PET images and the second sinogram data set is obtained from CT images.

Claim 159 (new): The method according to claim 148 wherein the first sinogram data set is obtained from MRI images and the second sinogram data set is obtained from PET images.

Claim 160 (new): The method according to claim 148 wherein the first sinogram data set is obtained from PET images and the second sinogram data set is obtained from MRI images.

Claim 161 (new): The method according to claim 148 further comprising the step of completing one or more iterations by substituting the fusion-aligned reprojection image for the first image.

Claim 162 (new): The method according to claim 148 wherein the first sinogram data set is obtained from a tomographic or volume-imaging modality.

Claim 163 (new): The method according to claim 148 wherein the second sinogram data set is obtained from a tomographic or volume-imaging modality.

Claim 164 (new): The method according to claim 148 wherein any of the sinograms or images are collected using fan-beam geometries.

Claim 165 (new): The method according to claim 148 wherein any of the sinograms or images are collected using cone-beam geometries.

Claim 166 (new): The method according to claim 148 wherein any of the sinograms or images are collected using helical geometries.

Claim 167 (new): The method according to claim 148 wherein any of the sinograms or images are collected using planar image or data converted into tomographic-equivalent images or sinograms, or volume images.

Claim 168 (new): The method according to claim 148 wherein the step of merging utilizes patient shape, size, or density information.

Claim 169 (new): The method according to claim 148 wherein the patient's size, shape, and/or anatomy has changed between the collection of the first and second images or data sets.

Claim 170 (new): A method of augmenting a tomographic projection image of a patient, the method comprising the steps of:

obtaining a first sinogram data set from a patient, the first sinogram data set including incomplete, imperfect or limited data;

obtaining a second sinogram data set from the patient using a different imaging apparatus or modality than the first sinogram data set, the second sinogram data set including complete data;

fusing the first sinogram data set to the second sinogram data set to obtain an aligned sinogram data set, so that optimal registration between the first and second sinogram data sets is obtained;

merging the first sinogram data set with the aligned sinogram data set by extracting data from the aligned sinogram data set that is missing from or not available in the first sinogram data set to obtain an augmented sinogram data set; and

reconstructing the augmented sinogram data set into a fusion-aligned reprojection image.

Claim 171 (new): The method according to claim 170 wherein the first sinogram data set is converted to an artifact-prone image.

Claim 172 (new): The method according to claim 170 wherein the step of fusing comprises using common radiotherapy patient setup protocols.

Claim 173 (new): The method according to claim 170 wherein the sinogram data sets are sufficiently well aligned that explicit fusion is not necessary.

Claim 174 (new): The method according to claim 170 wherein the first sinogram data set, the aligned sinogram data set and the augmented sinogram data set are represented by a data matrix wherein each row represents a gantry position, a gantry angle, or a ray angle; and each column represents a detector number, a detector distance, a detector angle, or a ray position; and a third sinogram dimension may optionally represent multiple detector rows.

Claim 175 (new): The method according to claim 170 wherein the first sinogram data set is obtained from megavoltage CT images and the second sinogram data set is obtained from kilovoltage CT images.

Claim 176 (new): The method according to claim 170 wherein the first sinogram data set is obtained from kilovoltage CT images and the second sinogram data set is obtained from megavoltage CT images.

Claim 177 (new): The method according to claim 170 wherein the first sinogram data set is obtained from CT images and the second sinogram data set is obtained from MRI images.

Claim 178 (new): The method according to claim 170 wherein the first sinogram data set is obtained from MRI images and the second sinogram data set is obtained from CT images.

Claim 179 (new): The method according to claim 170 wherein the first sinogram data set is obtained from CT images and the second sinogram data set is obtained from PET images.

Claim 180 (new): The method according to claim 170 wherein the first sinogram data set is obtained from PET images and the second sinogram data set is obtained from CT images.

Claim 181 (new): The method according to claim 170 wherein the first sinogram data set is obtained from MRI images and the second sinogram data set is obtained from PET images.

Claim 182 (new): The method according to claim 170 wherein the first sinogram data set is obtained from PET images and the second sinogram data set is obtained from MRI images.

Claim 183 (new): The method according to claim 170 further comprising the step of completing one or more iterations by substituting the augmented sinogram data set for the first sinogram data set.

Claim 184 (new): The method according to claim 170 wherein the first sinogram data set is obtained from a tomographic or volume-imaging modality.

Claim 185 (new): The method according to claim 170 wherein the second sinogram data set is obtained from a tomographic or volume-imaging modality.

Claim 186 (new): The method according to claim 170 wherein any of the sinograms or images are collected using fan-beam geometries.

Claim 187 (new): The method according to claim 170 wherein any of the sinograms or images are collected using cone-beam geometries.

Claim 188 (new): The method according to claim 170 wherein any of the sinograms or images are collected using helical geometries.

Claim 189 (new): The method according to claim 170 wherein any of the sinograms or images are collected using planar image or data converted into tomographic-equivalent images or sinograms, or volume images.

Claim 190 (new): The method according to claim 170 wherein the step of merging utilizes patient shape, size, or density information.

Claim 191 (new): The method according to claim 170 wherein the patient's size, shape, and/or anatomy has changed between the collection of the first and second data sets.